
Space Weather Technical Forecast

Issued on Tuesday, 06 February 2024 at 13:19 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: M-class flares expected, with a chance of isolated X-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate, with a long-period flare peaking at M4.2 at 06/0312UTC from AR3575, which was associated with type II and type IV radio emissions. There are twelve sunspot regions however most of these are small and either stable or fading with only two of particular note. AR3576 is a large and active region on the southeast disc, with a complex but ragged main leader including a strong delta spot and significant magnetic looping evident in SDO imagery. AR3575 is a smaller but still complex and active region in the southwest disc, which is becoming hard to assess due to both its southern and western location, however this consists of two main opposite polarity umbrae within a combined penumbra, leading to a further delta-configuration.

Preliminary analysis of the CME that left the Sun in association with the M flare from AR3575 this morning gives potential for a glancing blow late on 08 February or early on 09 February, but requires further examination.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE and DSCOVR at L1 were indicative of the onset of a fast wind, likely from CH96/+. Initially near background, at around 400 km/s, these rose from 05/1500 UTC to become slightly elevated at just under 500km/s, rising further to become elevated at around 520km/s from 06/0600UTC. Density was mostly average or below throughout. Interplanetary Magnetic field (IMF), Bt, was moderate at 8-11nT but has fallen to weak since around 06/0600UTC, at 6-8nT. The north-south component Bz, has varied between +9nT and -9nT. Phi angle was mostly positive (away from the Sun). Geomagnetic activity was mostly Quiet (Kp0-2), with an Unsettled (Kp3) interval in the early hours of the UTC day 06 February.

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux has been slightly elevated since the M-class flare this morning but remains below the S1 threshold. GOES16 high energy (greater than 2MeV) electron flux was at background. The associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold. At 06/0000UTC the 24-hour integrated fluence observation was 1.6e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity expected, with further M-flares and a chance of X-flares. These most likely from either AR3576 in the southeast, or from AR3575 in the southwest, although this risk decreases slightly day 3 onward as AR3575 recedes on the far-side.

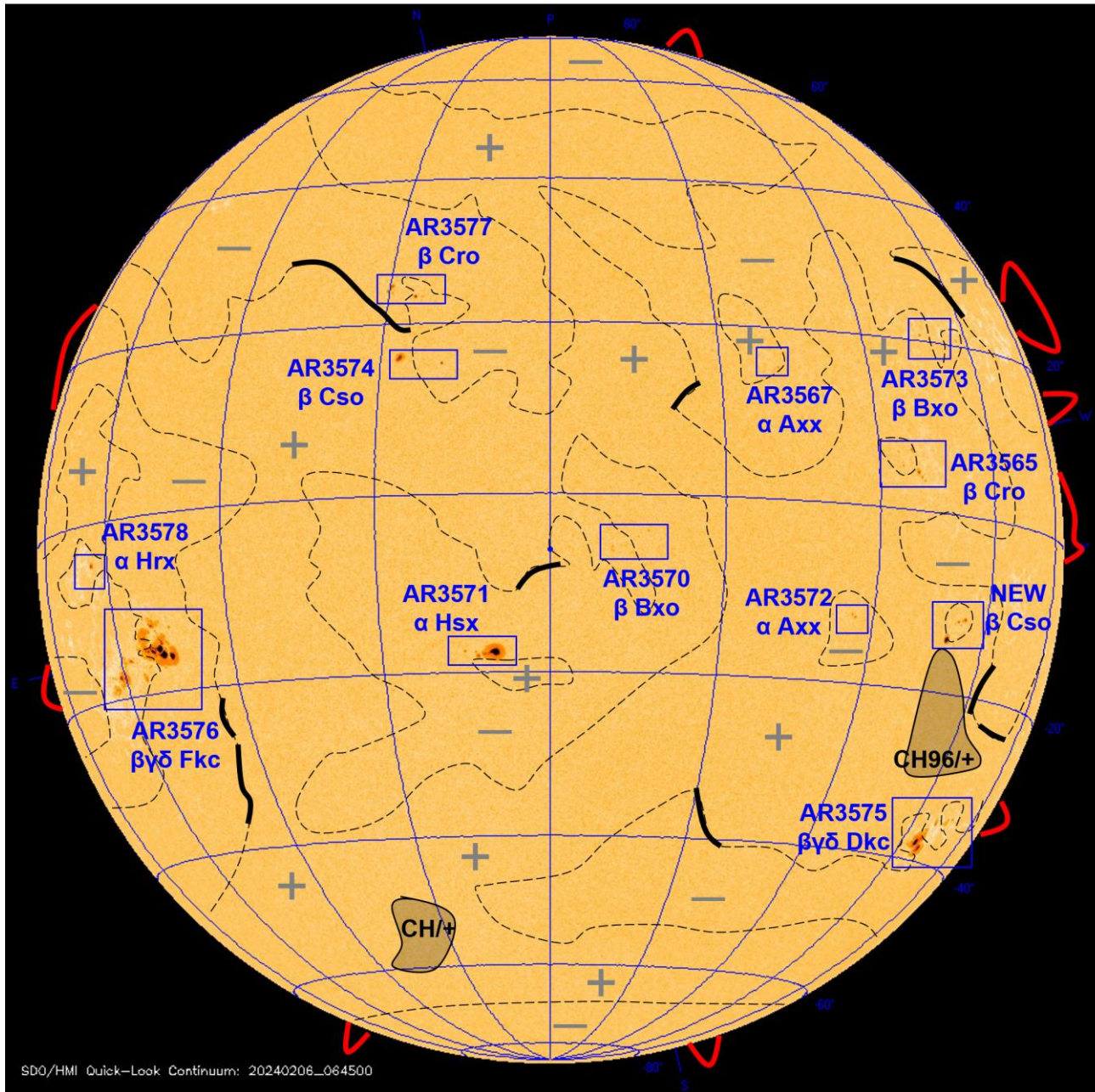
Solar Wind / Geomagnetic Activity: Current fast winds from CH96 are expected to gradually ease days 1-2 (06-07 February), with elevated speeds easing to background. The CME that left the Sun in association with the M4.2 flare in the morning of 06 February may provide a glancing blow late on 08 February or into 09 February, with chance of G1, but requires further analysis. Geomagnetic activity is expected to be mostly Quiet other than during the period of possible

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CME arrival.

Energetic Particles / Solar Radiation: High energy proton flux has the potential to rise in response to any significant flares, most likely from AR3575 at first, but increasingly from AR3576 as this moves into a more central location. This brings a slight chance of exceeding the S1 Minor Radiation Storm level. High energy electron flux (greater than 2MeV) is expected to remain mostly at background with the associated 24 hour fluence persisting below the Active threshold.

Figure 1. Solar Analysis Valid 06/0645UTC.



Key: Filament —, Prominence —, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

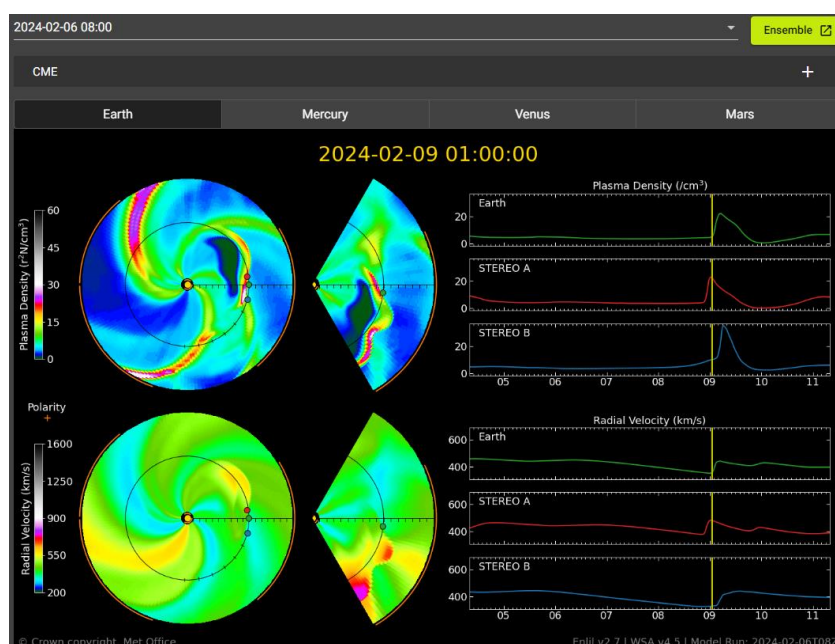
Ongoing fast wind from small and now largely obscured coronal hole 96 is expected to gradually ease later day 1 and into day 2 (06-07 Feb), with solar winds falling from elevated at just above 500km/s to background, below 400 km/s. The CME that left the Sun in association with the M4.2 flare in the morning of 06 February may provide a glancing blow late on 08 February or into 09 February, with chance of G1, but requires further analysis.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	1	1	10	30
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
06/0708	Partial	AR3575 M4.2 flare	SW disc	819 km/s	09/0100UTC	Preliminary analysis only, will be updated after further examination

Figure 2: Preliminary modelling of CME from early hours of 06 February using MOSWOC ENLIL



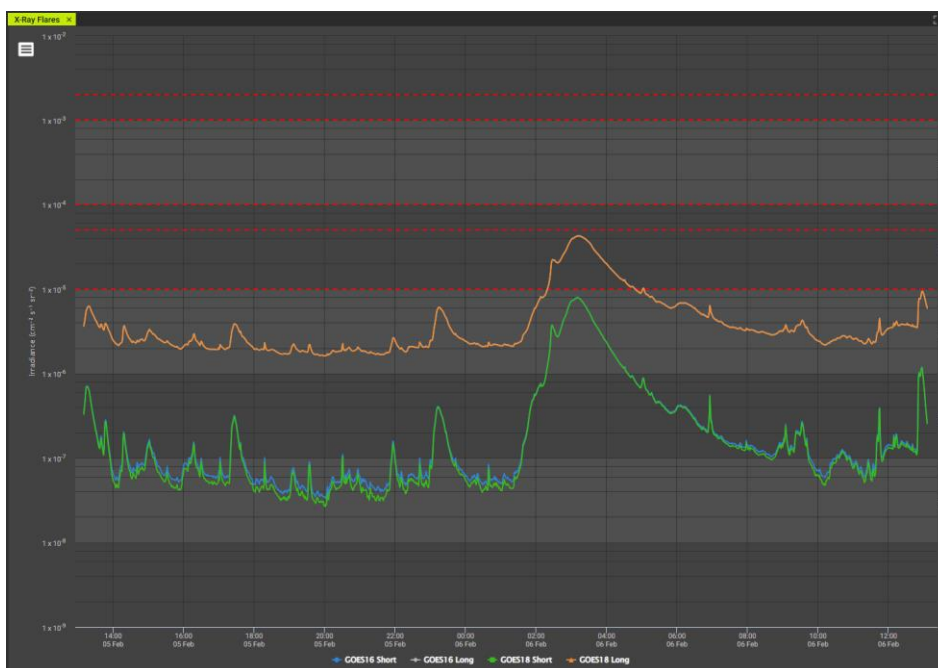
Radio Blackouts - X-Ray Flares:

Moderate activity is expected to continue with a chance of rising to High due to isolated X-class flares. The main risks for flaring are from AR3576 in the southeast and AR3575 approaching the southwest limb. The majority of other regions on the disc are small, stable and simple with some of these spots showing signs of fading.

AR3576 is a large region in the southeast disc and the source of the majority of flare activity over the past few days. Despite a rather ragged appearance and a recent reduction in activity, this has a strong delta within its main leader spot, with a broad area of looping evident in SDO-aia imagery. Along with an identifiable flux-rope and ongoing dynamical changes, this suggests the ongoing risk of notable flares. AR3575, while smaller, produced the M4.2 flare early on 06 February, and also has a visible delta spot, along with some evidence of magnetic looping building within its canopy. Furthermore, any apparent reduction in spot area may be due to its southern location, along with it approaching the western limb leading to an oblique viewing angle. It is due to rotate over the southwest horizon early day 3 (08 February), with a consequent decrease in flare risk.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	70	60
Very Active	R3 to R5 X Class	No	30	30	20	15

Figure 3: X-Ray Flares, showing peak of M4.2 at 06/0312UTC.



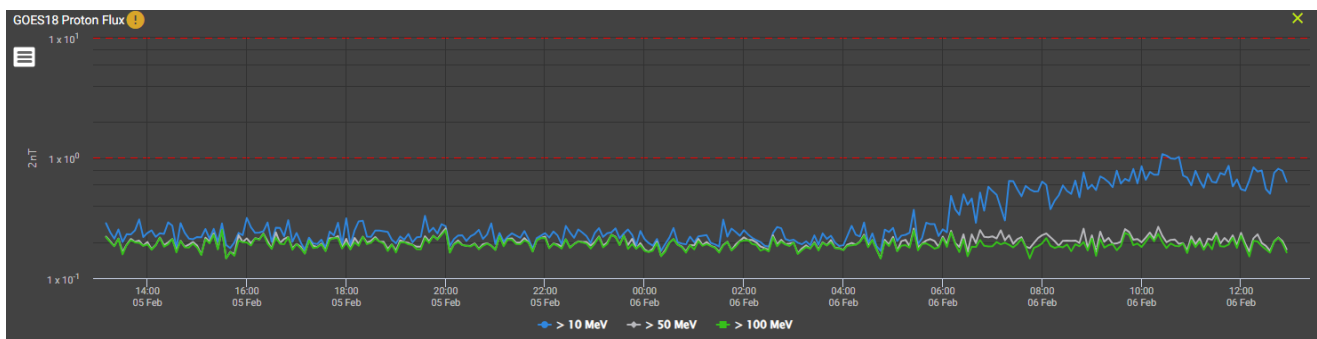
Solar Radiation Storms - (High Energy Protons):

GOES18 high energy (greater than 10MeV) proton flux is currently slightly elevated, in response to the M4.2 flare, but remains well below the S1 threshold. There is a chance of proton flux rising in response to any further notable flares, with a slight chance of exceeding the S1 Minor Radiation storm level. Initially the main risk is from AR3575, due to its position in the southwest of the disc, with the risk persisting as this moves over the western horizon later early day 3 (07 Dec) before gradually reducing after day 4. However, AR3576, which is currently in the eastern disc, will have moved to a more central disc location by this time, increasing the potential for proton events occurring due to any notable flares from this region.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	20	20	20	20
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)

Figure 4: GOES18 Proton Flux



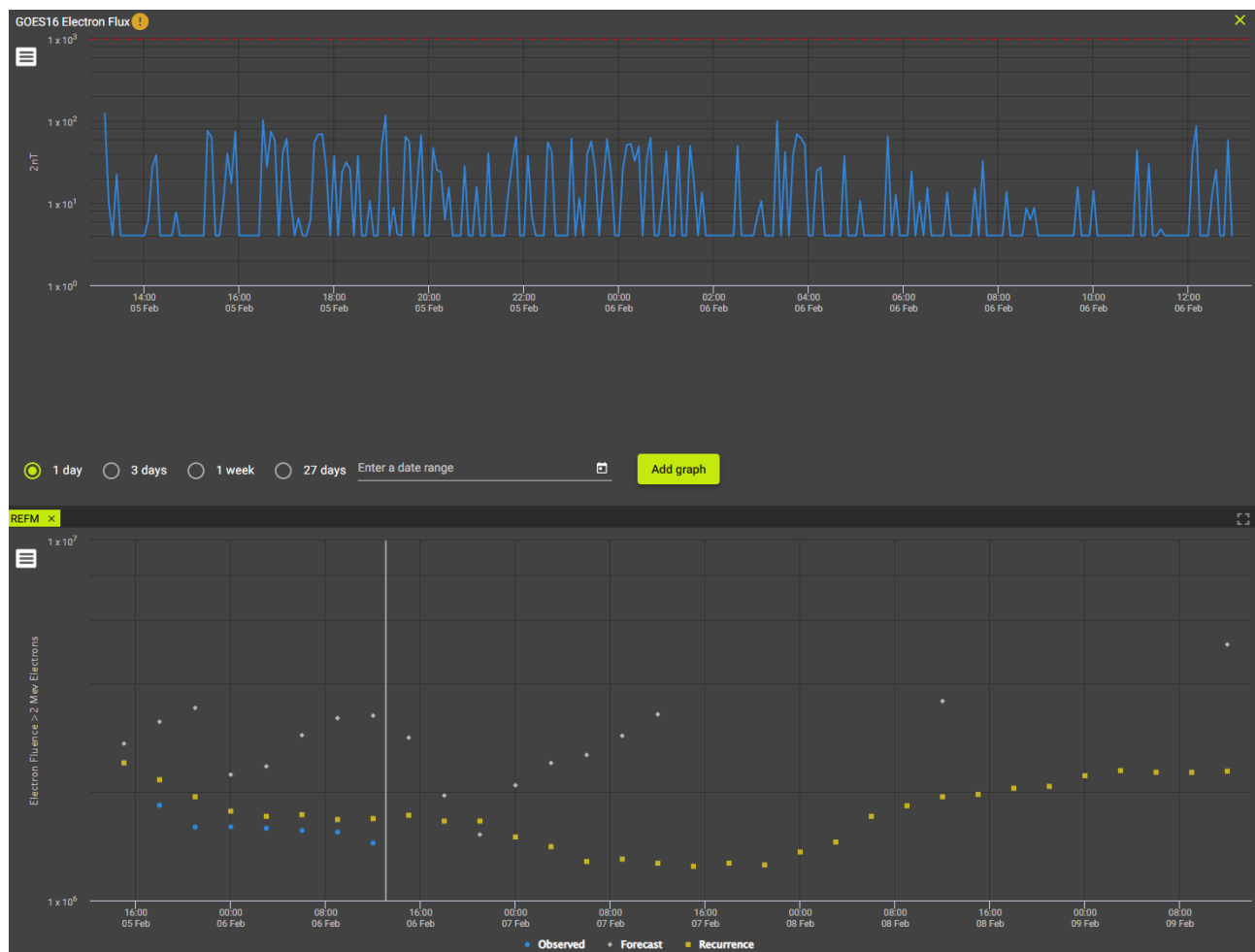
High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux (greater than 2MeV) as observed by GOES-16 is expected to persist at background, with the current fast wind enhancement unlikely to bring a notable increase in electron flux. There is a slight chance of brief Moderate flux day 2 (07 Feb) onward during the diurnal peak.

The associated 24 hour electron fluence is expected to remain well below the Active ($1\text{e}8$ integrated flux) threshold, as suggested by MOSWOC's REFM, which is currently giving good guidance.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	1	1	1
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: GOES16 Electron Flux (top) and MOSWOC REFM (bottom), thought to be giving good guidance currently.



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